

SOLVING AIR QUALITY ISSUES

Utilizing the power of FTIR





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All your process, facility and safety needs in one place.

Product Categories:

On-Line Analyzers - For gases and liquids. Technologies: electrochemical, catalytic, infrared, spectroscopy, spectrometry, chromatography, fourier transform infrared.

Process Control and Measurement - Flow, pressure, temperature, humidity, moisture, prowe, level.

Instrumentation - Gas detection, sound, noise, dust, iaq, calibration gases and regulators. Safety Equipment - Personal protective equipment, fall protection, first aid, spill control Calibration and Repair Services – to ISO 17025 standards

- On-site or in our state of the art calibration lab
- Calibration and repair of portable and fixed instruments
- Respirator maintenance SCBA, PAPR, airline, breather boxes
- Level A suit testing to ASTM F 1052 Pressure Test Method
- Fall protection equipment inspection Competent Person Fall Protection

Safety equipment and portable instruments: Safety Inc www.ESafetyInc.com

Process Instrumentation :

- New England ETA Process Instrumentation www.etapii.com
- Upstate NY Martech Controls www. martechcontrols.com

Calibration and Repair services: *iFacility Services* www.iFacilityServices.com

Agenda

FTIR technology overview Applications /Case Studies Q & A's



FTIR (Fourier Transform InfraRed) gas analyzers identify and measure gaseous compounds by their absorbance of infrared radiation.

This is possible because every molecular structure has a unique combination of atoms, and therefore produces a unique absorption spectrum when exposed to infrared light.

Instrumental analysis of the mid-IR spectrum (2 to 12 micrometer wavelength) enables the qualitative identification and quantitative analysis of the gaseous compounds in the sample gas.



FTIR analyzers are able to simultaneously measure multiple analytes in complex gas matrices, detecting virtually all gasphase species (both organic and inorganic, except diatomic elements N₂, O₂ etc. and noble gases He, Ne, etc.).

For example, the Gasmet FTIR gas analyzer collects a complete infrared spectrum (a measurement of the infrared light absorbed by molecules inside the sample gas cell) 10 times per second.

Multiple spectra are co-added together according to a selected measurement time (improving accuracy by raising the signal-to-noise ratio). The actual concentrations of gases are calculated from the resulting sample spectrum using a patented modified **Classical Least Squares analysis algorithm**.

gasmet

IR Technologies

Non-Dispersive IR instruments (NDIR) measure only separate wavelength bands, no information from other parts of the spectrum

Fourier Transform Infrared (FTIR) spectrometer measures all the IR wavelengths simultaneously and produces a full spectrum.



Interferometer

NDIR:

Only one component can be analysed from a single Measurement and interference cannot be compensated



All components can be analysed from single measurement and interferences are resolved





FTIR	NDIR
50, 200 or 600 readings per analysis based on selectable 5, 20, or 60 sec interval (10 readings/sec)	1 reading per analysis Measures a single wavelength with variable filter in mid-IR range
473 data points /scan	~ 26 data points / scan
• 25 with Configuration 1 PDA	• Up to 5 gases IF all gases are known and IF gases
50 with Configuration 2 Laptop	are not similar enough to cause cross interference
0.090 ppm Formald	dehyde 0.11 ppm
0.011 ppm Benz	zene 2 ppm
0.004 ppm Sulphur He	xafluoride 0.010 ppm
0.017 ppm Ethylene O	xide (Eto) 0.350 ppm
0.130 ppm Ammonia	a (NH3) 0.700 ppm
0.300 ppm Hydrogen Fl	uoride (HF) not available
0.010 ppm Freon	134a 0.170 ppm
Any unknown gas identified in the sample can	Can't identify if an unknown gas is present if that gas is
be analyzed and identified with software	not loaded in the library on the instrument



No cross interference.	Cross interference - like gases can't be speciated
Fixed mirror provides extreme stability, no need for annual adjustment	Adjustable mirrors typically require factory service at annual calibration.
Can be used and calibrated in any position. Ready for use in less than 1 minute No in-line chemical filter needed, only a particulate filter	Sensitive to orientation – calibrating in one position and using in another changes the readings Warm up time before accurate readings of 20- 30 minutes
Unaffected by temperature, humidity, or pressure changes	Requires use of in-line charcoal filter, filter must be routinely changed, no way to know if there is filter breakthrough Need to choose compensation for changes in temperature, pressure, or humidity
Rhodium coated lens impervious to corrosive chemicals	Corrosive chemicals degrade windows, eventually requiring costly replacement
Never requires a factory calibration. Internal laser is used as calibration reference with every measurement.	Annual factory calibration recommended, typically also includes adjustment of mirrors, \$ 1500-2000 per year, more for larger libraries
Accuracy : ± 2% of reading Precision is 0.01% Zero drift stability : ± 2% smallest measuring range per zero-point calibration interval	 ± 10 - 25 % of reading Quoted accuracy is based on only a single gas, doesn't take into account cross interference issues that cause inaccurate readings.

Understanding the power of FTIR¹ gas analysis



FTIR Gas Analysis using a combination of optical light measurement and a mathematical algorithm to measure many gases and their concentrations simultaneously.

1. FTIR = Fourier Transform Infrared

25 gases chosen & changed from a master library (335 gases).

Never needs recalibration

> Know what's in the air.

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The FTIR Gas Analyzer



Interferometer

Gas Cell



Compact – Rugged Fast scanning Vibration insensitive





Corrosion resistant sample cell Nickel-rhodium-gold plated



Corrosion resistant sample cells

- Inert Nickel-rhodium-gold plated mirrors & aluminium cell body
- Fixed mirrors (resilient to shocks & bumps of handling & transporting)
- Same rugged tough gas cell used in CEMS as ambient application
- Absorption to 9.8 m Single pass and multi-pass (White cell)
- Cell windows (ZnSe, immune to water vapour)
- Gas Measurement Range : Sub-ppm to % levels





😼 gasme

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A. Dual Functionality of FTIR

QUANTIFYING THE KNOWN

Calcme	et - Sample Spec	trum			-					-	
le Edit	t View Measu	re Options	Tools	Window	Help						
2	8 h 8	1	ha -	1	s 5s 2	0s 1M	зм О	>> 1	-}	8 K?	
Analysi	s Results - GAS-L	IB-DEMO 25	SN07123	8 <11 04 1	Rev2.LIB: I	Demo 071	238 3 solv	ents.SPE	1.		Sample Spectrum
h Con	nponent	Concentr	Unit			2010/25201	WININGSON		Range	Resid	C1CalcmetSamplesiDemo 071238 3 solvents SPE
1 Wat	er vapor H2O	0.07	vol-%						-	0.0024	2009-06-01 10-59-36
2 Carb	bon dioxide	44.48	ppm	12					2000	0.0024	
Carb	bon Monoxide	0.03	ppm						200	0.0006	0.90-
Nitre	ous Oxide	0.00	ppm						100	0.0006	0.80
Met	hane	0.12	ppm						10	0.0027	0.70
Sulf	ur Dioxide	0.00	ppm						100	0.0164	0.70-
Amr	monia	0.17	ppm						50	0.0015	0.60-
Ethy	lene	0.00	ppm						100	0.0015	0.50-
Prop	pane	0.56	ppm						100	0.0026	0.40-
Hexa	ane	0.27	ppm						100	0.0027	0.30-
Form	maldehyde	0.22	ppm						50	0.0008	0.20
2 Bena	zene	0.37	ppm						50	0.0032	
3 Tolu	lene	0.48	ppm						200	0.0027	0.10- with I William / William /
4 m-X	lylene	0.00	ppm						200	0.0052	0.00
5 Acet	tone	136.97	ppm						200	0.0044	-0.10-
Met	hanol	0.99	ppm			24			100	0.0032	4000 3500 3000 2500 2000 1500 1000
Etha	Inol	42.13	ppm		- 10-				100	0.0032	Min: -0.1296 Max: 0.9975
s Isop	ropanol	27.39	ppm						100	0.0032	
) Diet	hyl ether	0.00	ppm						50	0:0042	
Ethy	lene Oxide	0.00	ppm						50	0.0020	
L Seve	oflurane	0.00	ppm						50	0.0048	
2 Dest	flurane	0.02	ppm						50	0.0042	
3 Freo	on 22	0.00	ppm						50	0.0042	Ouantify the Known
Freo	on 134a	0.08	ppm						50	0.0042	
5 Sulfi	ur hexafluoride	0.00	ppm						20	0.0016	
1 Amb	bient pressure	1027.00	mbar						1200	0.0000	
6 Cell	temperature	31.00	°C						40	0.0000	



B. <u>Dual Functionality of FTIR</u> IDENTIFYING THE UNKNOWN

Analysis Results - GAS-I	JB-DEMO_25	_SN071238_c	11_04_Rev2.LIB: Demo 071238 3 solvents.SPE	0	B 123	Sample Spectrum
Component Water vapor H2O Carbon dioxide Carbon dioxide Carbon Monoxide Carbon Monoxide Carbon Monoxide Methane Sulfur Dioxide Methane Sulfur Dioxide Propane Hexane Formaldehyde Benzene Toluene Methanol Isopropanol Diethyl ether Softwane Suffurane Sulfurane Sulfur hexafluoride Ambient pressure Sulfur hexafluoride	Concentr 0.07 45.37 0.13 0.00 0.35 0.00 3.35 0.00 5.13 0.00 5.13 0.00 5.13 0.00 5.13 0.00 0.29 0.00 10.27 145.51 16.07 29.09 0.00 10.07 145.51 16.07 29.09 0.00 1.06 0.00 0.00 0.00 1.06 0.00	Unit vol-% ppm ppm ppm ppm ppm ppm ppm ppm ppm pp		Range 3 2000 2000 100 100 50 100 100 50 200 200 200 200 200 200 200 50 50 50 50 50 50 50 50 50 50 50 50 5	Resid 0.0024 0.0024 0.0025 0.005 0.005 0.005 0.0232 0.0232 0.024 0.0271 0.021 0.024 0.0257 0.0011 0.0271 0.0257 0.0211 0.0257 0.0232 0.0200 0.0232 0.0030 0.0000 0.0000 0.00000 0.00000 0.000000	Contraction of the second seco



CALCMET[™] **ADVANCED LIBRARY SEARCH**

Identification of unknown gases



IDENTIFYING "UNKNOWN" GASES

The Power & Speed of FTIR !



Advanced Library Search

Search Reference Library, over 350+ gases

Search NIST/EPA Library, over 5000 gases

Library Search Results - 2009-06-01 10:59:3	C:\CalcmetSamples\Demo 071238 3 solvents.SPE
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Library	Component	Fit	Concentration
Librarysearch.LIB	Acetone C3H6O	97.46	144.58
Librarysearch.LIB	Ethanol C2H5OH	96.09	41.52
Librarysearch.LIB	Isopropanol C3H8O	93.86	26.02



FTIR = SIMULTANEOUS MULTI-GAS READINGS (25)

	l 🔁 Ana	Ilysis Results - DX4040 Se	miconductor A	pplication	on Library				
1.0	Ch	Component	Concentration	Unit	Ca	alibration Range	Ran	Residual	Selecti
easured Compo	nents	Arsine	0.00	ppm			50	0.0001	Residual
	2	Phosphine	0.00	ppm			100	0.0000	/
	3	Dichlorosilane	0.00	ppm		×	200	0.0001	
	4	Nitrogen trifluoride NF3	0.00	ppm			100	0.0000	
Concentratio	5	Silane SiH4	0.00	ppm			100	0.0000	
Concentratio	6 6	Dichlorosilane	0.00	ppm			100	0.0000	
	7	Trichlorosilane	0.00	ppm			100	0.0000	
	8	Hexamethyldisilazane	0.00	ppm	Bar gr	aph display	100	0.0000	
	9	Nickel Carbonyl	0.00	ppm			100	0.0001	
	10	Hydrogen bromide	0.00	ppm	K		100	0.0000	
	11	Hydrogen chloride	10.00	ppm			50	0.0000	
	12	Hydrogen fluoride	0.00	ppm			200	0.0000	
	13	Diborane	0.00	ppm			100	0.0000	
	14	Silicon tetrachloride	0.00	ppm	Audio &	Visual	200	0.0000	
	15	Silicon tetrafluoride	0.00	ppm	Alarma		100	0.0000	
	16	Sulfur hexafluoride	0.00	ppm	Alainis	/ yas	50	0.0000	
	17	Boron trichloride	0.00	ppm			200	0.0000	
	18	Trimethylamine	0.00	ppm			100	0.0000	
	19	Ammonia	0.00	ppm			200	0.0000	
	20	Bromoform	0.00	ppm			100	0.0000	
	21	Freon C 318 C4F8	0.00	ppm			100	0.0000	
	22	Octafluorocylcopentene C5F8	0.00	ppm			100	0.0000	
Up to 25	23	Water vapor	-0.00	vol-%			3	0.0000	
gases >	24	Carbon dioxide	-0.11	ppm			1000	0.0001	
94000	25	Carbon monoxide	0.00	ppm			200	0.0001	

FTIR SENSITIVITY (MDL'S) BASED ON 1 MINUTE SAMPLING (600 READINGS) IN NITROGEN

- 1. Acrolein (0.13 ppm)
- 2. Acrylonitrile (0.18 ppm)
- 3. Ammonia (0.07 ppm)
- 4. Arsine (0.01 ppm)
- 5. Benzene (0.07 ppm)
- 6. Boron trichloride (0.005 ppm)
- 7. Carbon dioxide (< 10 ppm)
- 8. Carbon monoxide (0.12 ppm)
- 9. Carbon disulfide (0.09 ppm)
- 10. Dichloromethane (0.06 ppm)
- 11. Ethylene oxide (0.08 ppm)
- 12. Formaldehyde (0.04 ppm)
- 13. Hydrogen chloride (0.10 ppm)
- 14. Hydrogen cyanide (0.17 ppm)
- 15. Hydrogen fluoride (0.15 ppm)
- 16. Methane (0.03 ppm)
- 17. Methyl mercaptan (0.21 ppm)
- 18. Nitrogen dioxide (0.19 ppm)
- 19. Nitrous oxide (0.01ppm)
- 20. Phosgene (0.01 ppm)
- 21. Phosphine (0.10 ppm)
- 22. Sulfur dioxide (0.02 ppm)
- 23. Sulfuryl fluoride (0.02 ppm)
- 24. Toluene (0.06 ppm)
- 25. Water Vapour

Sub-ppm / ppb gas dependent







What can't be measured with FTIR technology

All gases absorb mid-IR wavelengths except:

 diatomic homonuclear molecules such as O2, N2, H2, Cl2, F2,

 The noble gases (He, Ne, Ar..) & "H2S" is a very weak IR absorber



> Know what's in the air.

FTIR Gas Analyzer can rapidly assess site safety & exposure risk

- Natural Gas leaks at low levels (Methane (ppm) & Mercaptans)
- Toxics at Clandestine Lab. clean up site
- Measuring for the presence of **Freons** at industrial sites
- Acid gases such as HCl, HF and HCN, Nitric Acid
- Screening for TIC's, TIM's & CWA's
- Chemical manufacturing Methyl Bromide, Chloropicrin, Vikane,
- Refinery Toxics Benzene, Styrene, Aldehydes, Hexane, Methanol, Carbon Disulfide
- Semiconductor Plants Arsine, Phosphine, Silanes, Boron
- Hospitals Formaldehyde, Hydrogen Peroxide, Ethylene Oxide, Peracetic Acid
- IAQ investigations
- LEED certification

Case Study :

Hospital lab. staff evacuated after chemical leak



Region 2 South TSRT Coordinator, was notified of a potential gas or vapor leak in the Human Pathology Laboratory at St. Joseph Hospital, MI.

"We were advised that the **suspicion was increased levels of Formaldehyde**. We ran tests in five different work areas within the lab. With the FTIR gas analyzer we were able to simultaneously test for 50 different gases/vapors using quantitative and qualitative analysis. The results of our tests revealed that the substance was Toluene and not Formaldehyde. The levels were well within safe limits of all found substances as well as TWA's [Time Weighted Averages]"

"The FTIR Gas Analyzer performed flawlessly and proved it's capability beyond doubt. The TSRT had a successful training deployment and had many educational benefits from the experience." Bob Lovelace _ Region 2 South TSRT Coordinator

Case Study

FREON LEAK GOES UNDETECTED AT A "TEXAS UNIVERSITY"



Ch	Component	Concentration	Unit	Range	Resid
1	Water vapor	0.62	vol-%	3	0.0004
2	Carbon dioxide	674.13	ppm	2000	0.0014
3	Carbon Monoxide	0.00	ppm	200	0.0015
4	Nitrous Oxide	0.30	ppm	100	0.0008
5	Sulfur Dioxide	0.00	ppm	100	0.44.25
6	Nitrogen Dioxide	2.06	ppm	50	0.0022
7	Methane	1.84	ppm	100	0.0103
8	Formaldehyde	0.25	ppm	50	0.0010
9	Toluene	0.00	ppm	200	0.0101
10	Ammonia	2.93	ppm	50	0.0824
11	Hydrogen Chloride	0.00	ppm	50	0.0022
12	Hydrogen Fluoride	0.00	ppm	50	0.0006
13	Hydrogen Cyanide	0.00	ppm	50	0.0005
14	Arsine	0.01	ppm	50	0.0013
15	Phosgene	0.18	ppm	50	0.0020
16	Acrylonitrile	15.67	ppm	50	0,4521
17	Ethylene Oxide	0.15	ppm	50	0.0005
18	Boron Trichloride	0.00	ppm {	50	0.4521
19	Phosphine	0.00	ppm	50	0.4671
20	Acrolein	0.00	ppm	50	0,0031
21	Methyl Mercaptan	32.35	ppm	200	0.0059
22	Carbon Disulfide	0.82	ppm	200	0.0009
23	Sulfuryl fluoride	0.00	ppm	50	0.4581
24	Dichloromethane	0.00	ppm	200	0.4495
25	Benzene	0.00	ppm	50	0.0144
226	Cell temperature	28.00	°C	40	0.0000





Library Search Results	DX404	10 Search results	250	161 B	-
Library	International States	Component	Fit	Concentration	
LibrarySearch_DX40308x40_c11	_11_Rev4.LIB	Frenn 134A	970791	- 30/65	4
		4	0.00	0.00	11
			0.00	0.00	
	5	$an 131\Delta$	0.00	0.00	
	Fr		0.00	0.00	
		30 ppm	0.00	0.00	
		86 PP	0.00	00.0	
			0.00	0.00	
			0.00	0.00	. *

ASSESSING WORKER EXPOSURE & Case Study : SAVING ENERGY / MONEY – PRESENTATION AT I2SL (INTERNATIONAL INSTITUTE FOR SUSTAINABLE LABORATORIES)

The Lab Inhalation Risk Assessment (LIRA) study is currently in development and is expected to be a key safety and efficiency component of Harvard University Lab Ventilation Management Plan.

The challenge of the LIRA study is to use a new portable technology [Gasmet DX4040 FTIR Gas Analyzer] in the development of a process for quantifying potential inhalation exposures in the labs.

The goal of the project is to use LIRA as a method for reducing general lab ventilation rates from six air changes per hour when occupied, down to four air changes when occupied and two air changes when occupied, in spaces where the Harvard ventilation guidelines are the driving factor of the air change rates.

Case Study :

Field Study Plan

Steps:

- 1. Master using the Gasmet DX4040 for lab applications and identify participating labs.
- 2. Collect air samples throughout the labs under normal working conditions at the current ventilation rate. (6 air changes per hour)
- 3. Assess air quality generally, as well as during certain research processes.
- 4. Lower ventilation rate to 4 ACH occupied 2 ACH unoccupied and reassess.
- 5. Measure changes in building energy use.
- 6. Define acceptable ambient lab air quality.

Results



> Know what's in the air.



Case Stud

Results & Next Steps

Results for first test period of July 2018 vs August 2018

- 1. Supply and Exhaust Fan Electrical Energy Change
 - a) Fan CFM reduction resulted in 15% kWh cost reduction (6% of total bill)
 - b) 1 Month Net savings of \$3,089
- 2. Airflow Energy Change (normalized for CDD)
 - a) Supply side increased by 0.14%
 - b) Exhaust side decreased by 0.15%
 - c) 1 Month Net savings of \$49
- 3. Projected Annual Savings: \$37,680
 - For only for 65% of available Open Lab Spaces (22% of gross building area)

Next Steps – deeper analysis of HVAC system performance at the new operating parameters



Case Study

UTILITY COMPANY FUNDING FOR ENERGY SAVINGS

Harvard partnered with Eversource on this project with a goal of saving energy.

Eversource funded part of the purchase of the Gasmet unit.

Eversource is working closely with Harvard to quantify the energy savings, and looking at developing an incentive program based on the results of the Harvard LIRA results.

This would be similar to existing incentives for other commercial energy savings – steam trap surveys and repairs, compressor surveys and upgrades, etc.

DIACETYL MONITORING Case Study : IN COFFEE ROASTING

30 compounds measured due to the complex matrix

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John Greivell

HEALTHCARE FACILITIES – COMPLETE MONITORING SOLUTION FOR TOXIC GASES

1. Operating & Recovery Rooms **WAG's –** Desflurane, Nitrous Oxide, Sevoflurane, Enflurane, Isoflurane

2. Toxic Sterilant Gases

- a). Formaldehyde
- b). Hydrogen Peroxide
- c). Ethylene Oxide
- d). Peracetic Acid

Formalde

🍤 qəsmet









Testing for Post-Fire Toxic Gases

"Removal of respiratory protection during fire overhaul activities or in the general area can expose firefighters and fire investigators to an unknown variety of toxic chemicals and particulates."

Chemical Exposures	OSHA TWA	# Fires	# fires
	PEL (ppm)	Analyzed	found
Acrolein	0.1	11	4
Aldehydes (total	1000	20	10
anphatic)	n.a.	29	19
Ammonia	50	29	8
Benzene	1	29	10
Benzyl chloride	1	12	3
Carbon disulfide	30	3	3
Carbon monoxide	50	38	30
Formaldehyde	0.75	29	4
Furfural	5	3	3
Glutaraldehyde	<u>n.d.</u>	12	12
Hydrogenchloride	5	37	8
Naphthalene	10	37	7
Nitrogen dioxide	3	37	28
Nitrogen monoxide	25	29	28
Ozone	0.1	29	21
Phenol	5	29	9
Sulfur dioxide	5	29	2
Styrene	100	29	25
Toluene	200	29	27



A portable FTIR Gas Analyzer can quickly test for these gases and alert firefighter if site is clear to remove SCBA.

Paper by_Deric C. Weiss and Jeff T. Miller Tualatin Valley Fire & Rescue 2011



FTIR VALIDATION & CERTIFICATION

FTIR Methodology accepted by leading test organizations including :

- NIOSH Method 3800 (Organic & Inorganic gases by extractive FTIR spectrometry)
- USEPA Method 320
- ASTM Method D6348
- TUV & MCERTS 3rd party verification

100	NIOSH Manual of Analytical Methods	NIOSH > NIOS	H Manual of Anal	htical Methods
EDGEWOOD	Indexes of Methods	NIOSH Pub	lication Numb	er 2003-154 (3rd Supplement)
Contract and internet and internet come	What's New	NIOSH A	Aanual of	f Analytical Methods
NCRC-19-486	Order NMAM Protocols	Chemica	l CAS Numb	ber
EVALUATION OF GASHET" DX-4013 SERIES		0123	45628	9 ALL
OURIER TRANSFORM INFRARED GAS ANALYZER	NIOSH Homepage	CAS Numb	er Listing -	All CAS Numbers
The second se	Workplace Safety &	Chemical	Method No.	Method Name
Bernet Y Hung Schestigen of Heiseland Antonion	Publications and Products		0500 2	PARTICULATES NOT OTHERWISE REGULATED, RESPIRABLE 0600 PARTICULATES NOT OTHERWISE REGULATED, TOTAL 0500
V	Programs		8004 🔁	POLYCHLOROBIPHENYLS in serum 8004
	N	100-00-5	2005	NITROAROMATIC COMPOUNDS 2005 p-NITROANILINE 5033
20090826068		100-37-8	2007 📩	AMINDETHANOL COMPOUNDS I 2007
an a second		100-41-4	1501	HYDROCARBONS, AROMATIC 1501
T		100-42-5	3800 🐔	ORGANIC AND INORGANIC GASES BY EXTRACTIVE FTIR

NIOSH Publications and Products

				ΤÜ	TÜV		
				TUV there	and Group		
	a far far far						
	DIN EN ISO 14956 and prEN 15267-3 calculation for QAL 1 in DIN EN 14181						
	Monufacturer data						
	Masshedaror	Emacon Mossuthment Gesnet CEMS					
	Huserstand Sylvers						
	Serial Number	033505 and 03095					
	Monaureg Principle	110	Succession and				
	TÜLIPuta						
	TÜV Pepört	036/21200448/A					
	Date	04.57 2005					
	Edky		Contraction of the				
	Measurement Component	() SHO	5 35 F	ngire* -			
	Pusheation of the cross sensitivity (CS)		CS Amer				
	to 31 Vol% Oxygen		6,00 mp/m*				
	to 30 Vol% Humidity		0,00 mg/m*				
	to 300 mg/m² Certon monoida		0.12 mg/m*				
	to 10 merry Matana		D.00 mg/m*				
	so 100 mg/m² Distingen monoside		0,15 mg/m ²				
	In 300 regim ¹ Margan manadale		0,10 mg/m*				
	to 30 mg/m² Natugen dicuide		0.00 mg/m ²				
03	to 1000 mater' Substur dioxide		-0.20 mg/m ^a				
	to 200 mg/m* Hydrogen chlorida		"nign 00.0				
	Burry of positive cross sensitivities		0,59 mp/m*				
	Sum of negative cross sensitivities		-0,20 mg/m*				
	Calculation of the combined standard uncertainty			AT			
	Test Value		DX em./	13	1404 mag 1		
	Lack of the	4	-0.26 mg/m*	-0,15 mgm*	0.022		
	Biggent intertexence (positiv or tagents)		pran uituta.	0.34 mg/m*	0,114		
	Spar som in the field test	then .	0.02 mphil	D.G.T. empirit	0,000		
	Constitute to participa without low	10	0.00 motort	0.00 morest	5,000		
	Sendade to ambient temperature	u .	-0.29 mp/m*	-0,18 mg/m*	2,027		
	Dependence on supply wittage	Um	-0,26 regint*	-0,15 mp/m*	0,022		
	Repeatability at span	44	0,09 mphint	0,05 mg/m*	0,003		
	Field reproductality	up	0.14 regist	D,OR FIGHT	0,000		
	Uncertainly of the test gas at the reference point	04	0.30 mg/m*	0.57 mg/m*	0,030		
	Combined standard uncertainty dust	14 N. = (12(Mann.)) ²		0,507			
	Total extended uncertainty	NA * 10 UL = 14 * 1,95		0,994			
	Robbie total expendent uncertainty	Us in this of the lenst 15 mg/m?		5,5			
		Up in % of the limit 15 mptm*		40.0			

QUESTIONS?

Joel Myerson

joel@ESafetyInc.com